

REMARKS

By the present amendment and response, claims 1, 2, 21, and 25 have been amended to overcome the Examiner's objections. New claims 29 and 30 have been added. New claim 29 is the independent form of claim 22, which includes all of the limitations of base claim 21. New claim 30 depends from claim 29 and corresponds to dependent claim 23. New claims 29 and 30 are thus allowable according to the Examiner's comments on page 9 of the Final Office Action dated December 16, 2003. Thus, claims 1-8 and 21-30 remain in the present application and claims 29 and 30 are now in condition for allowance. Reconsideration and allowance of outstanding claims 1-8 and 21-28 in view of the following remarks are requested.

In the *final rejection* of December 16, 2003, the Examiner has rejected claims 1 and 21 under 35 USC §102(e) as being anticipated by U.S. patent number 6,211,561 to Bin Zhao ("Zhao"). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by amended independent claims 1 and 21, is patentably distinguishable over Zhao. However, Applicant reserves the right to provide declarations and/or documents under 37 CFR §1.131 to "swear behind" the effective filing date of Zhao.

Subject to Applicant's reserved right to establish priority of the present invention under 37 CFR §1.131, Applicant submits that the present invention, as defined by amended independent claim 1, teaches, among other things, fabricating a damascene structure comprising depositing a second capping layer directly on a first capping layer, which has been deposited over a first dielectric layer, and "etching one or more air

trenches into the damascene structure so that the air trenches are positioned between selected metal lines, wherein the second capping layer is situated over the selected metal lines.” As disclosed in the present application, a first capping layer is deposited over a first dielectric layer, trenches are formed in the first capping layer and the first dielectric layer, and the trenches are filled with a metal, such as copper, to form metal lines. As disclosed in the present application, a second capping layer is deposited over the metal lines and the first capping layer to serve as a dielectric barrier for the copper.

As disclosed in the present application, air gaps, i.e. air trenches, are formed in the first dielectric layer between selected metal lines. As a result, the present invention achieves an improved damascene interconnect structure that advantageously reduces parasitic capacitance between metal lines within the same metal layer (i.e. intra-layer capacitance) as well as between metal lines in adjacent metal layers (i.e. inter-layer capacitance).

In contrast, Zhao does not teach, disclose, or suggest fabricating a damascene structure comprising depositing a second capping layer directly on a first capping layer, which has been deposited over a first dielectric layer, and “etching one or more air trenches into the damascene structure so that the air trenches are positioned between selected metal lines, wherein the second capping layer is situated over the selected metal lines.” Zhao specifically discloses depositing dielectric layer 60 over dielectric layer 18, and etching air gaps 22 in dielectric layer 60 and dielectric layer 18 between conductive lines 16a-16d. See, for example, column 5, lines 36-41, column 6, lines 47-48, and Figure 5 of Zhao. However, allowing dielectric layer 60 to be a first capping layer as

specified in amended independent claim 1, Zhao fails to teach, disclose, or suggest forming a second capping layer directly over the first capping layer.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by amended independent claim 1, is not suggested, disclosed, or taught by Zhao. As such, the present invention, as defined by amended independent claim 1, is patentably distinguishable over Zhao.

The present invention, as defined by amended independent claim 21, teaches, among other things, “depositing a sealing layer over the damascene structure having air trenches to seal the air trenches,” “depositing a polish stop layer over the sealing layer,” and “depositing an etch stop layer over the polish stop layer.” As disclosed in the present application, SiN layer 75, which acts as a good polish stop layer, is deposited over sealing layer 72A, and SiO₂ layer 77, which serves as an etch protection layer, is deposited over SiN layer over SiN layer 75. Page 13, lines 1-3 and 14-22 of the present application. Thus, as disclosed in the present application, by providing SiN layer 75, i.e. a polish stop layer, underneath SiO₂ layer 77, i.e. an etch stop layer, the present invention allows SiO₂ layer 77, which contains unwanted contaminants from previous processing steps that can affect the reliability of the interconnect, to be effectively removed without damaging the sealing layer situated below SiN layer 75. The present invention as defined in amended independent claim 21 also provides similar advantages as the present invention as defined in amended independent claim 1 discussed above.

In contrast, Zhao does not teach, disclose, or suggest “depositing a sealing layer over the damascene structure having air trenches to seal the air trenches,” “depositing a

polish stop layer over the sealing layer,” and “depositing an etch stop layer over the polish stop layer.” Zhao specifically discloses depositing second dielectric layer 62C over sealing layer 26C and depositing hard mask 19D over second dielectric layer 62C. See, for example, column 10, lines 42-51 and Figure 31B of Zhao. In Zhao, second conductive layer 32C is formed on hard mask 19D. See, for example, column 11, lines 43-53 and Figure 31B of Zhao. However, Zhao fails to teach, disclose, or suggest depositing a polish stop layer over a sealing layer and depositing an etch stop layer over the polish stop layer as specified in amended independent claim 21.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by amended independent claim 21, is not suggested, disclosed, or taught by Zhao. As such, the present invention, as defined by amended independent claim 21, is patentably distinguishable over Zhao.

In the *final rejection* of December 16, 2003, the Examiner has further rejected claims 1 and 4-8 under 35 USC §102(e) as being anticipated by U.S. patent number 6,159,840 to Jyh-Ming Wang (“Wang”). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by amended independent claim 1, is patentably distinguishable over Wang. However, Applicant reserves the right to provide declarations and/or documents under 37 CFR §1.131 to “swear behind” the effective filing date of Wang.

Subject to Applicant’s reserved right to establish priority of the present invention under 37 CFR §1.131, Applicant submits that, in contrast to the present invention as defined by amended independent claim 1, Wang does not teach, disclose, or suggest

fabricating a damascene structure comprising depositing a second capping layer directly on a first capping layer, which has been deposited over a first dielectric layer, and “etching one or more air trenches into the damascene structure so that the air trenches are positioned between selected metal lines, wherein the second capping layer is situated over the selected metal lines.” Wang specifically discloses depositing stop layer 206 on dielectric layer 204, depositing dielectric layer 208 on stop layer 206, and depositing dielectric material 214 on dielectric layer 208. See, for example, column 3, lines 7-22 and Figure 2C of Wang. However, Wang fails to teach, disclose, or suggest depositing a second capping layer directly on a first capping layer as specified in amended independent claim 1.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by amended independent claim 1, is not suggested, disclosed, or taught by Wang. As such, the present invention, as defined by amended independent claim 1, is patentably distinguishable over Wang. Thus, claims 4-8 depending from amended independent claim 1 are, *a fortiori*, also patentably distinguishable over Wang for at least the reasons presented above and also for additional limitations contained in each dependent claim.

In the *final rejection* of December 16, 2003, the Examiner has further rejected claims 1-3 under 35 USC §102(e) as being anticipated by U.S. patent number 6,204,165 to Uttam Shyamalindu Ghoshal (“Ghoshal”). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by amended independent claim 1, is patentably distinguishable over Ghoshal. However, Applicant reserves the right to

provide declarations and/or documents under 37 CFR §1.131 to “swear behind” the effective filing date of Ghoshal.

Subject to Applicant’s reserved right to establish priority of the present invention under 37 CFR §1.131, Applicant submits that, in contrast to the present invention as defined by amended independent claim 1, Ghoshal does not teach, disclose, or suggest fabricating a damascene structure comprising depositing a second capping layer directly on a first capping layer, which has been deposited over a first dielectric layer, and “etching one or more air trenches into the damascene structure so that the air trenches are positioned between selected metal lines, wherein the second capping layer is situated over the selected metal lines.” Ghoshal specifically discloses depositing silicon nitride layer 135, i.e. a first capping layer, on dielectric layer 115, depositing dielectric layer 116 on silicon nitride layer 135, and depositing silicon nitride layer 136, i.e. a second capping layer, on dielectric layer 116. See, for example, column 2, lines 66-67, column 3, lines 1-3, and Figure 4A of Ghoshal. Thus, in Ghoshal, dielectric layer 116 separates silicon nitride layers 135 and 136, i.e. respective first and second capping layers. Furthermore, Ghoshal fails to teach, disclose, or suggest depositing a second capping layer directly on a first capping layer.

In Ghoshal, air 410 is situated between copper interconnects 155 and 159. See, for example, Figure 4G of Ghoshal. However, in Ghoshal, copper interconnect 159 is situated above the second capping layer, i.e. silicon nitride layer 136. Thus, in Ghoshal, the second capping layer, i.e. silicon nitride layer 136, is not situated over selected metal

lines as specified in amended independent claim 1. Moreover, Ghoshal fails to teach, disclose, or suggest a second capping layer situated over selected metal lines.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by amended independent claim 1, is not suggested, disclosed, or taught by Ghoshal. As such, the present invention, as defined by amended independent claim 1, is patentably distinguishable over Ghoshal. Thus, claims 2-3 depending from amended independent claim 1 are, *a fortiori*, also patentably distinguishable over Ghoshal for at least the reasons presented above and also for additional limitations contained in each dependent claim.

In the *final rejection* of December 16, 2003, the Examiner has further rejected claims 21 and 24-28 under 35 USC §103(a) as being unpatentable over Wang in view of U.S. patent number 6,159,840 to Grill et al. (“Grill”). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by amended independent claim 21, is patentably distinguishable over Wang and Grill, singly or in combination.

In contrast to the present invention as defined by amended independent claim 21, Wang does not teach, disclose, or suggest “depositing a sealing layer over the damascene structure having air trenches to seal the air trenches,” “depositing a polish stop layer over the sealing layer,” and “depositing an etch stop layer over the polish stop layer.” Wang specifically discloses depositing dielectric material 214 on dielectric layer 208 and over air-gap 213. See, for example, column 3, lines 7-22 and Figure 2C of Wang. In Wang, photoresist layer 216, which is used to define dielectric material 214, is formed on

dielectric material 214. Photoresist layer 216 is removed after dielectric material 214 has been defined. See, for example, column 3, lines 23-25 and Figure 2D of Wang. However, Wang fails to teach, disclose, or suggest depositing a polish stop layer over a sealing layer and depositing an etch stop layer over the polish stop layer, as specified in amended independent claim 21.

In contrast to the present invention as defined by amended independent claim 21, Grill does not teach, disclose, or suggest “depositing a sealing layer over the damascene structure having air trenches to seal the air trenches,” “depositing a polish stop layer over the sealing layer,” and “depositing an etch stop layer over the polish stop layer.” Grill specifically discloses lining cavities 150 and 160 with conductive diffusion barrier material 170 prior overfilling the cavities with conductive wiring/via material 180. See, for example, page 3, paragraph [0041] and Figures 1C and 1D of Grill. Assuming, for the sake of argument, that conductive diffusion barrier material 170 is polish stop layer, Grill fails to teach, disclose, or suggest depositing an etch stop layer over the polish stop layer, as specified in amended independent claim 21.

The Examiner states that it would have been obvious to include a polish stop layer, i.e. conductive diffusion barrier material 170 in Grill, over the sealing layer, i.e. dielectric material 214 in Wang, prior to forming conductive line 220b. However, in Wang, since photoresist layer 216, i.e. the “etch stop layer,” is utilized to pattern dielectric material 214 during the formation of conductive line 220b, a barrier layer, such as conductive diffusion barrier material 170 in Grill, would not be utilized underneath photoresist layer 216. Thus, Grill fails to cure the deficiencies of Wang discussed above.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by amended independent claim 21, is not suggested, disclosed, or taught by Wang and Grill, singly or in combination. As such, the present invention, as defined by amended independent claim 21, is patentably distinguishable over Wang and Grill. Thus, claims 24-28 depending from amended independent claim 21 are, *a fortiori*, also patentably distinguishable over Wang and Grill for at least the reasons presented above and also for additional limitations contained in each dependent claim.

Based on the foregoing reasons, the present invention, as defined by amended independent claims 1 and 21 and claims depending therefrom, is patentably distinguishable over the art cited by the Examiner. Thus, dependent claims 2-8 and 22-28 are also patentably distinguishable over the art cited by the Examiner. For all the foregoing reasons, an early allowance of outstanding claims 1-8 and 21-28 and an early Notice of Allowance for all pending claims 1-8 and 21-30 is respectfully requested.

Respectfully Submitted;
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